

# **Key Challenges in Biocontainment BSL-3 Lab Design**

***Presented by:***

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# Biocontainment Classifications

- CDC/NIH Guidelines (BMBL)
  - BSL-1 through BSL-4
- USDA Animal Guides (ARS 242)
  - ABSL-1 through ABSL-4
  - BSL-3Ag for large animals



# Biosafety in Microbiological and Biomedical Laboratories (BMBL)

Defines Laboratory Biosafety Levels (BSL) Criteria and Animal Biosafety Level (ABSL) Criteria

- Published by the CDC-NIH



CLARK, RICHARDSON & BICKUP  
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# Classification Overview

- Level 1 in Russia = Level 4 in US
- Our focus today is on BSL-3
- BSL-3E (aka BSL-3+; aka BSL-3 Aug.)
  - Dress to enter; shower out
  - Autoclave for solid waste
  - Liquid effluent decontamination
  - Gas decontamination of Lab capability





# Biocontainment Considerations

- NFPA Codes
- Specialized Equipment
  - Mass Spectrometry
  - NMR
  - Robotics
- Primary Containment
- Secondary Containment
- Security
- Community Perception

# Biocontainment Philosophy

- Protect the People in Lab, the Product, the Public
- Primary Containment
  - Fume Hoods
  - BSCs
  - Glove Boxes/Isolators
- Secondary Containment
  - Room Level Containment
  - Room Pressurization & Airflow Direction
- Waste Handling/Decontamination
  - Double Contained piping w/Leak Detection
  - Kill Systems (EDS)



# Neighboring Classifications

- BSL-2
  - Uses a Class IIA BSC
    - ❖ 30% recirc to room; 70% over the work surface
    - ❖ HEPA filtered
- BSL-4
  - Uses a Class III BSC glovebox (“cabinet lab”), or
  - Pressurized Suit (“suit lab”)
  - Chemical shower for decon. (30% lysol sol’n).



# Planning Steps

- Define Agent(s)
- Determine Biosafety Level
- Determine Screening Process
  - Animals?
  - Clinical Trials?
- Determine Staffing Levels
- Develop Room Sizes
- Engineered Systems are Developed





# Planning Issues

- Controlled Access to Lab Areas
- Shared Common Equipment Area
- Containment – Airlocks/Shower in/out
- Clean Steam Autoclave for Wastes
- Support Space
- Decontamination
  - Routine & Hazard Event



# Facility Challenges

- Functional Relationships/Adjacencies
- Operational Flows
  - People in/out
  - Material in/out
  - Waste in/out
  - Equipment in/out

# Facility Challenges (Cont'd)

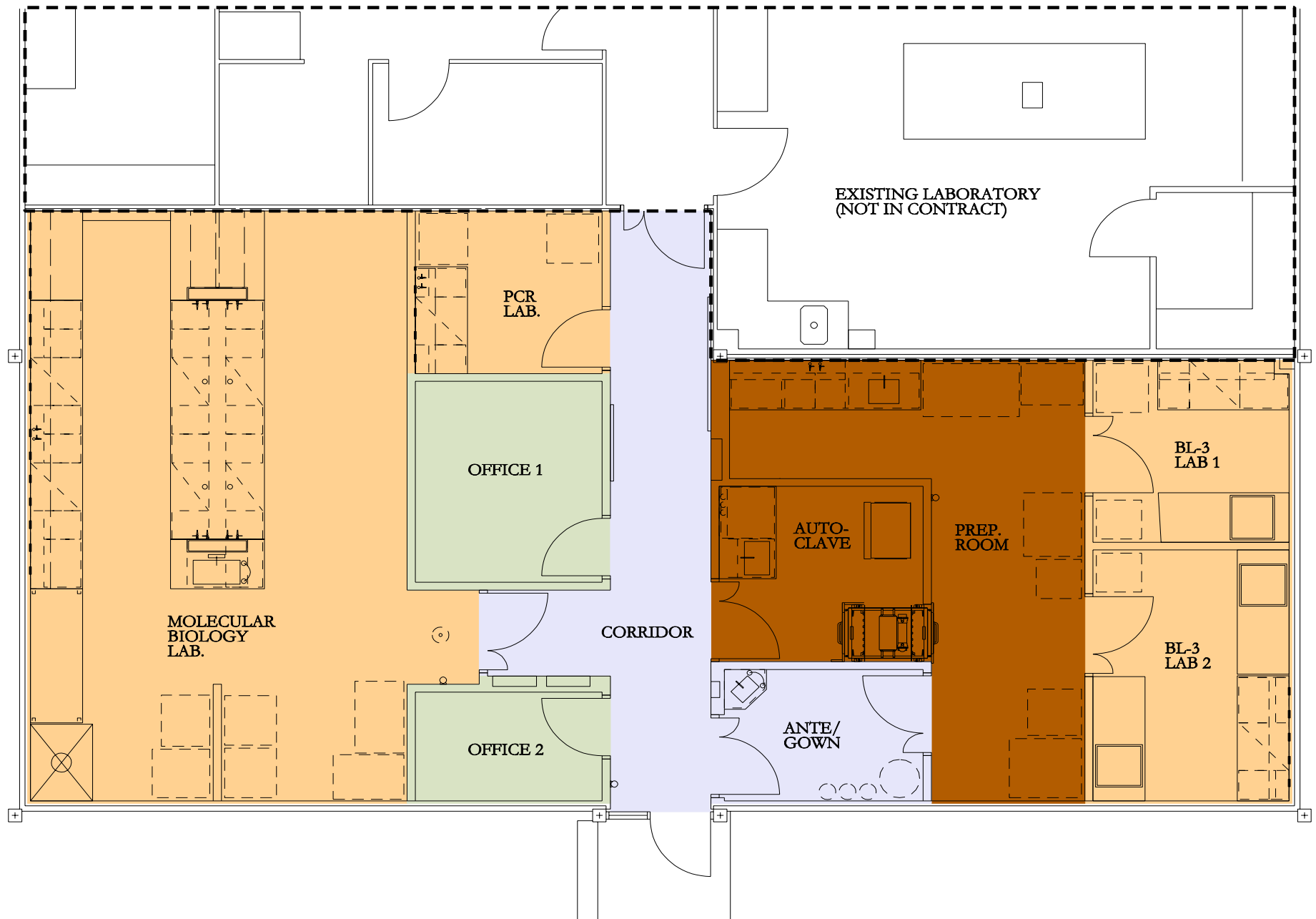
- Safety & Security
  - Gowning
  - Showering
  - Decontamination
  - Operation & Maintenance Protocols
  - Security Access Control & Monitoring
  - Agent Inventory and Storage Control

# Facility Challenges (Cont'd)

- Building Components
  - Circulation
  - Stacking
  - Utility Services
  - Hazardous Materials Handling
  - Floor-to-Floor Height
  - Finishes
  - Lighting









# HVAC Issues

- Air Handling Systems
- Redundancy/Reliability
- HEPA Filtration (BI/BO)
- Pressurization Schemes
- Terminal Equipment & Maintenance
- Directional Airflow

# HVAC Issues (Cont'd)

- Exhaust Systems
  - Decontamination
- Controls
- Energy Recovery
- Commissioning
- Wind Wake Analysis
  - OA Intake
  - Exhaust Air Stream





# BSL-3 and ABSL-3

BSL-3 is applicable to work done with exotic agents which may cause serious or lethal disease as a result of exposure by the inhalation route.

ABSL-3 is applicable to animals exposed to exotic agents that present potential of aerosol transmission and of causing serious or lethal disease.

# Challenges of BSL-3

- Standard BSL-2 practices plus
  - Controlled access
  - Waste Decon.
  - Lab clothing Decon before laundering
- Primary Containment
  - Biosafety Cabinet (BSC)
  - PPE (lab clothing, gloves)

# Challenges of BSL-3 (Cont'd)

- Secondary Containment
  - Physical Separation from Access Corridors
  - Self-closing double doors
  - 100% Exhaust, with HEPA filters
  - Negative Airflow to Lab
  - Hand Washing Sink
  - HVAC Alarms
  - Autoclave for Waste
  - Vacuum Disinfectant Traps



# Design/Construction Issues

- Coordinated Drawings
- Sealed Penetrations
  - Ductwork, Conduits
  - Partitions
- Commissioning
  - Start plan during design and 1<sup>st</sup> day of const.
- Costs
  - Be careful with SF cost figures



# When your P.I. Says “BSL-3”

- Understand Why?
- Understand Specific Research Goals
- How Many Different Agents?
- What Procedures will produce Aerosols?
- How will Agents be Delivered?
- Coordinate with Safety, Security, and A/E
- Get EXPERTISE in A/E and Contractor

# When your P.I. Says “BSL-3 in Future”

- Identify Future Location – top floor
- Site below Mechanical Penthouse
- Save Space for Filtration & Exhausts
- Save Spare E. Power (or space for add'l)
- Plan for Redundancy

# “Net” vs. “Gross” SF

- “Net Assignable”
  - Principal Investigator (P.I.) Research Space
- “Net Support Area”
  - Lab Support
  - Gown in/out, Showers
- “Gross Circulation”
  - Stairwells, Elevators, Code compliance requirements
- “Gross Mechanical Space”
  - Equipment to Condition, Pressurize

Total = “Gross Building Area”

# Net-to-Gross

- Net-to-Gross SF Decreases as Containment Level Increases
  - “Typical” BSL-3 = 40-50% Net-to-Gross
    - ❖ Cost approx. \$600/SF
  - “Typical” BSL-4 = 30% Net-to-Gross
    - ❖ Cost approx. \$1,000/SF





# Do's and Don'ts

- Don't use a BSL-3 when one isn't needed
- Don't Design a BSL-3 “just in case”
- Don't overbuild a BSL-3
- Don't use a BSL-4 when one isn't needed (\$\$)
- Do a Risk Assessment
- Biological Agents
  - Bacterial
  - Fungal
  - Parasitic
  - Viral

# Sustainability

- Building Envelope to Reduce Solar Load
- Harvest Storm Water for Irrigation
- Harvest Gray Water for Irrigation
- Recover HVAC Condensate for Make-up
- Evaluate Sizes of Once-Thru Air Spaces

# Sustainability (Cont'd)

- Lighting Types
  - Natural Daylighting
  - Occupancy Controls
  - More Task Lighting
- Materials of Construction
  - “Green” products, such as hardwood, veneer and plywood from certified, sustainable forests